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WIND SHEAR IN THE JET STREAM AT WHITE SANDS MISSILE RANGE

PREPARED BY

MISSILE METEOROLOGY DIVISION

U. S. ARMY
ELECTRONICS RESEARCH AND DEVELOPMENT ACTIVITY
WHITE SANDS MISSILE RANGE
NEW MEXICO

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A B S T R A C T

A discussion of wind shear in the jet stream over White Sands Missile Range, New Mexico is presented. Wind data collected utilizing the GMD-1 svstem are used to calculate vectorial wind shear. The maximum jet wind speed could not be significantly correlated to the maximum wind shear for any particular observation. Mean vectorial wind shear and standard deviation for each thousand feet of height in the jet stream are included.

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INTRODUCTION

A jet stream is defined by Byers [1] as a concentrated wind current of pronounced magnitude in a west-to-east motion. The jet stream is frequently observed over White Sands Missile Range (WSMR) during the months of November through March. The average height of the center of the stream is approximately 32,000 feet above WSMR and is normally 10,000 feet thick, i.e., from 25,000 to 35,000 feet above the range.

Large balloons ascending through the jet stream in the troposphere have burst because of the large shearing stress encountered. The purpose of this study is to determine if a statistical relationship exists between the maximum jet wind speed and the expected maximum vectorial wind shear.

THEORY

The change in a vectorial wind field along a given line in space is considered a wind shear. It can further be defined as the change in wind velocity with respect to change in height and mathematically noted as:

$$W_s = \frac{\partial \vec{V}_h}{\partial Z}$$

where W_s is the wind shear, $\vec{V}_h$ is horizontal wind velocity and Z is height.

If we define the wind vector as V_i; the East-West component of V_i as X_i; and the North-South component of V_i as Y_i, then:

$$X_i = V_i \sin \theta_i$$

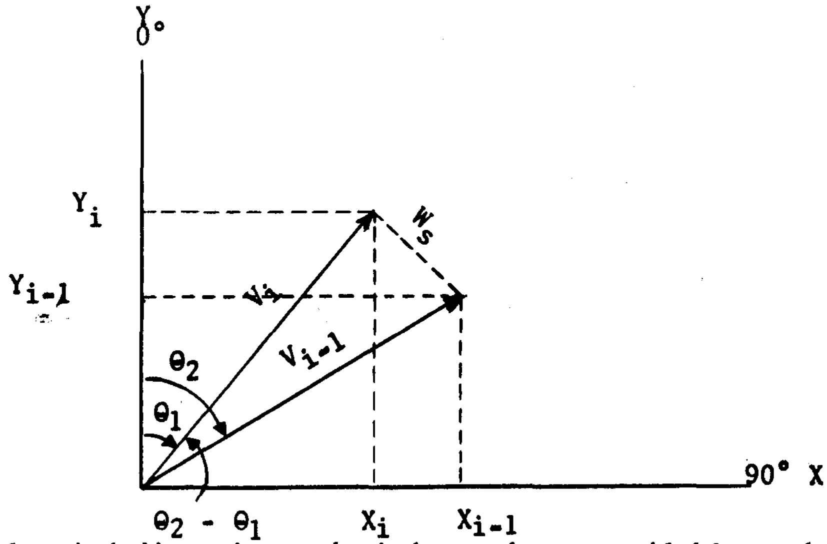
$$Y_i = V_i \cos \theta_i$$

where θ_i is the wind direction and i = 1, 2, 3, ... number of levels. South and West components are negative. The coordinate system used conforms with meteorological concepts where angles are generated clockwise from the positive Y coordinate which is zero degrees in this case. (See diagram, page 2.)

The vectorial wind shear (W_{si}) is then calculated from:

$$W_{si} = \left[(X_i - X_{i-1})^2 + (Y_i - Y_{i-1})^2\right]^{1/2}.$$

Derivation of this equation can be seen in the following diagram:



If only wind direction and wind speed are available rather than the wind components and one needs only the total vectorial wind shear, the law of cosines can be applied such that

$$(W_{si})^2 = V_i^2 + V_{i-1}^2 - 2V_iV_{i-1} \cos (\theta_2 - \theta_1).$$

ACCURACY

Wind shear cannot be obtained directly by present techniques. It is usually computed from wind data which, in turn, are computed from data obtained utilizing various instruments, such as theodolites, radar, GMD-1, etc. In this study, the GMD-1 was utilized to obtain wind data. Three basic problems inherent in calculating wind from the GMD-1 are given below.

1. Since under jet stream conditions the balloon is rapidly carried away from the ground receiving equipment, the angle that the balloon makes with respect to the GMD and the ground drops below 12 degrees in a short period of time.

Below this angle, the signal from the airborne instrumentation can be reflected from roof tops, wires, ground, etc., and the GMD-1 transmits an erroneous elevation and/or azimuth angle. A small error in elevation angle under 12 degrees can result in a large error in wind velocity.*

*Terrain characteristics and the instrumentation site at White Sands Missile Range required a smoothing technique for the elevation angle when this angle was below 12°. The smoothing technique consisted of taking three elevation angles (angles are recorded every minute) and averaging, i.e., if the elevation angle for the fiftieth minute is below 12°, then the forty-ninth, fiftieth and fifty-first minute elevation angles are averaged and the averaged value assigned to the fiftieth minute.

2. The present computer program at WSMR is designed to smooth the data when the elevation angle is below 12 degrees. This means that significant variations which are necessary to determine accurate shear are filtered out.

3. The technique of evaluating wind over a layer tends to smooth out significant variations.

Sidney Lees [2] has shown that a high order of "technical excellence" is required to measure wind shears in the troposphere since the upper limit of the wind shear is of the order of 10^{-2} sec^{-1} (10 ft. per sec. per 1000 ft.). Arnold [3] in his discussion of the theory of wind-shear measurements considers the assumptions made in obtaining wind measurements for computing wind shear for any given level. In particular, he points out the error involved in averaging the wind over a layer, assigning this value to the mid-point of the layer, and then subtracting this value from the value of the preceding layer to compute wind shear.

DATA ANALYSIS

Rawinsonde data from November 1961 through March 1962 at WSMR yielded 80 useable observations for this study. The terrain at the observational site is relatively flat, with mountains located approximately 12 miles to the west of the site averaging 8,000 feet MSL in elevation.

For purposes of this investigation, it was assumed that GMD-1 wind measurements were sufficiently accurate to compute wind shear in the jet stream even though limiting angles* had been encountered and that a jet stream was present when wind speed of 100 knots or greater was encountered in the troposphere.

Two methods were used in calculating the wind shear. First, wind shear for each thousand feet in height through the jet stream was computed. The lowest level considered was 1000 feet below the first reported 100-knot wind (reported in 1000-foot increments) and the highest level was 1000 feet above the last reported 100-knot wind. All vector wind shears were considered positive values, since a negative value would indicate only the direction of shear.

The second method consisted of grouping the observations according to maximum jet wind speeds, i.e., selecting all observations that had a maximum jet wind speed from 100 to 109 knots, 110 to 119 knots, etc. The maximum vector wind shear was calculated for each observation in each speed group.

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*Limiting angles are defined as any elevation angle below 12 degrees since the computer programming of the rawinsonde uses a smoothing technique to compute the winds below this angle.

RESULTS

The average wind shear vectors over White Sands Missile Range as shown in Table I ranged from 1.1×10^{-2} sec^{-1} (10.9 feet per second per 1000 feet) to 2.0×10^{-2} sec^{-1}. The layers in Table I correspond to 1000-foot intervals upward through the jet stream. However, since the jet stream height varies from day to day, the values in each layer cannot be assigned to any specific height.

Table II indicates the absolute mean of the maximum wind shear vector that can be expected for a given wind speed increment. Note that the mean of the maximum vectorial wind shear and the standard deviation increase as the maximum wind speed increments increase.

There were four cases of extreme wind shear tabulated from the 80 observations. Vectorial wind shear in these cases ranged from 79 to 129 feet per second per 1000 feet. Reisig [4] in his study of wind shear over WSMR found four cases with wind shears greater than 131 feet per second per 1000 feet and seven cases with shears greater than 50 feet per second per 1000 feet in a period of one year. Some of the extreme cases can probably be attributed to instrumental error. Instrumental errors [5, 6, 7] for wind speed are considered to have a standard deviation of 5.1 feet sec^{-1} per 1000 feet below 50,000 feet, increasing with height.

Out of the 80 observations, there were 29 observations where the maximum wind shear occurred at the top of the jet stream and 10 observations at the bottom of the jet stream. In 18 additional observations the maximum shear occurred within the jet stream and the winds were decreasing with altitude. There were also 17 cases where the winds were increasing with altitude. Six observations were not considered since the thickness of the jet stream was less than 4000 feet.

A quartile distribution was calculated (Figure 1) to ascertain symmetry of the data. The distribution shows that the data were almost symmetric for wind speed increments up to 129 knots. From 130 to 149 knots the data are skewed to the right while for 150 to 159 knots data are insufficient for a proper evaluation. From the graph, one can assume that 50 per cent of the time the maximum wind shear will fall between 16 and 27 feet per second per 1000 feet for maximum jet wind speed values between 100 to 109 knots. At the higher jet wind speed, for example 140 to 149 knots, the maximum wind shear would be between 30 to 46 feet per second per 1000 feet 50 per cent of the time.

The average wind shear can be computed as a function of maximum wind increments from the wind profile [8] in Figure 2. Wind shear values as calculated from these curves are comparable to the mean shear values computed for WSMR. If the mean wind shears computed from the three curves are compared with maximum wind shears computed locally for different speed increments, it will be noted that the maximum wind shears for WSMR are three times as strong as those computed from the curves. For example, Curve 1 indicates that for a maximum wind ranging from 102 to 112 knots, the average wind shear is approximately 8 feet per second per 1000 feet whereas the

TABLE I

Absolute Mean and Standard Deviation of Vectorial Wind Shear for each 1000 Feet Upward Through the Jet Stream at White Sands Missile Range. (N = Number of Samples.)

Layer	N	Mean Sec-1	Sigma	2 Sigma
1	80	.0182	.0167	.0334
2	80	.0145	.0088	.0176
3	79	.0139	.0089	.0178
4	72	.0134	.0142	.0282
5	69	.0120	.0097	.0194
6	64	.0109	.0094	.0188
7	60	.0129	.0088	.0176
8	57	.0138	.0112	.0224
9	51	.0146	.0095	.0190
10	46	.0167	.0133	.0266
11	44	.0193	.0147	.0294
12	34	.0208	.0152	.0304
13	26	.0194	.0126	.0252
14	22	.0202	.0183	.0366
15	20	.0196	.0130	.0260
16	14	.0153	.0111	.0222
17	11	.0148	.0084	.0168
18	10	.0141	.0104	.0208
19	9	.0168	.0125	.0250
20	8	.0196	.0135	.0270
21	8	.0203	.0129	.0258

TABLE II

Maximum Jet Wind Velocity vs Maximum Shear Vector

Figures in Parenthesis are the Number of Observations Considered

Maximum Wind (Knots)	Absolute Mean of Max. Shear (Sec^{-1})	Sigma	2 Sigma	Avg. Height of Max. Shear (Ft. MSL)
100-109 (9)	.0217	.0061	.0122	40,000
110-119 (13)	.0231	.0061	.0122	35,000
120-129 (16)	.0291	.0094	.0188	37,000
130-139 (14)	.0323	.0104	.0208	37,000
140-149 (8)	.0371	.0092	.0184	37,000
150-159 (11)	.0380	.0139	.0278	38,000
160-169 (3)	.0353	.0202	-----	40,000

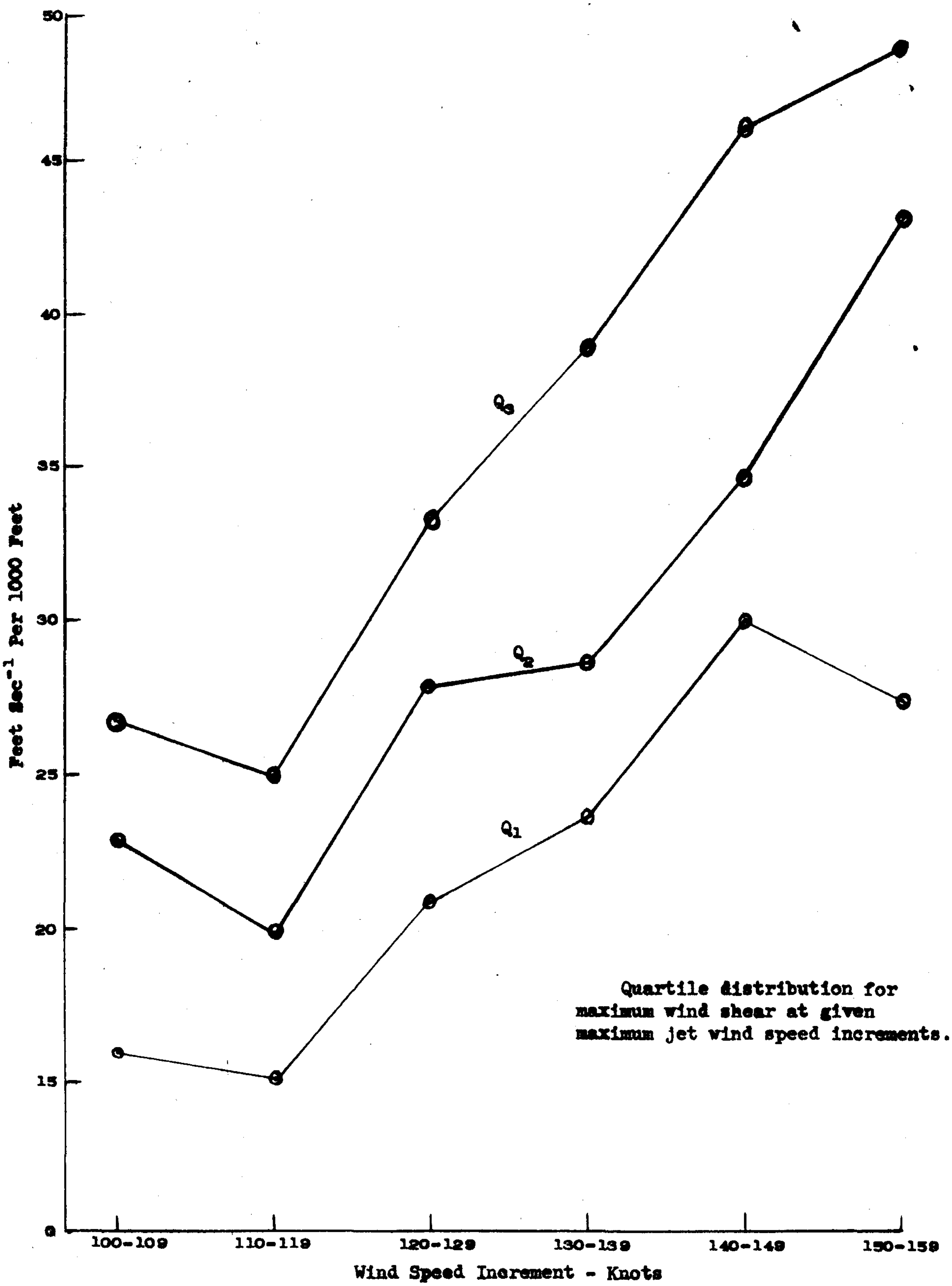


Figure 1. Quartile Distribution

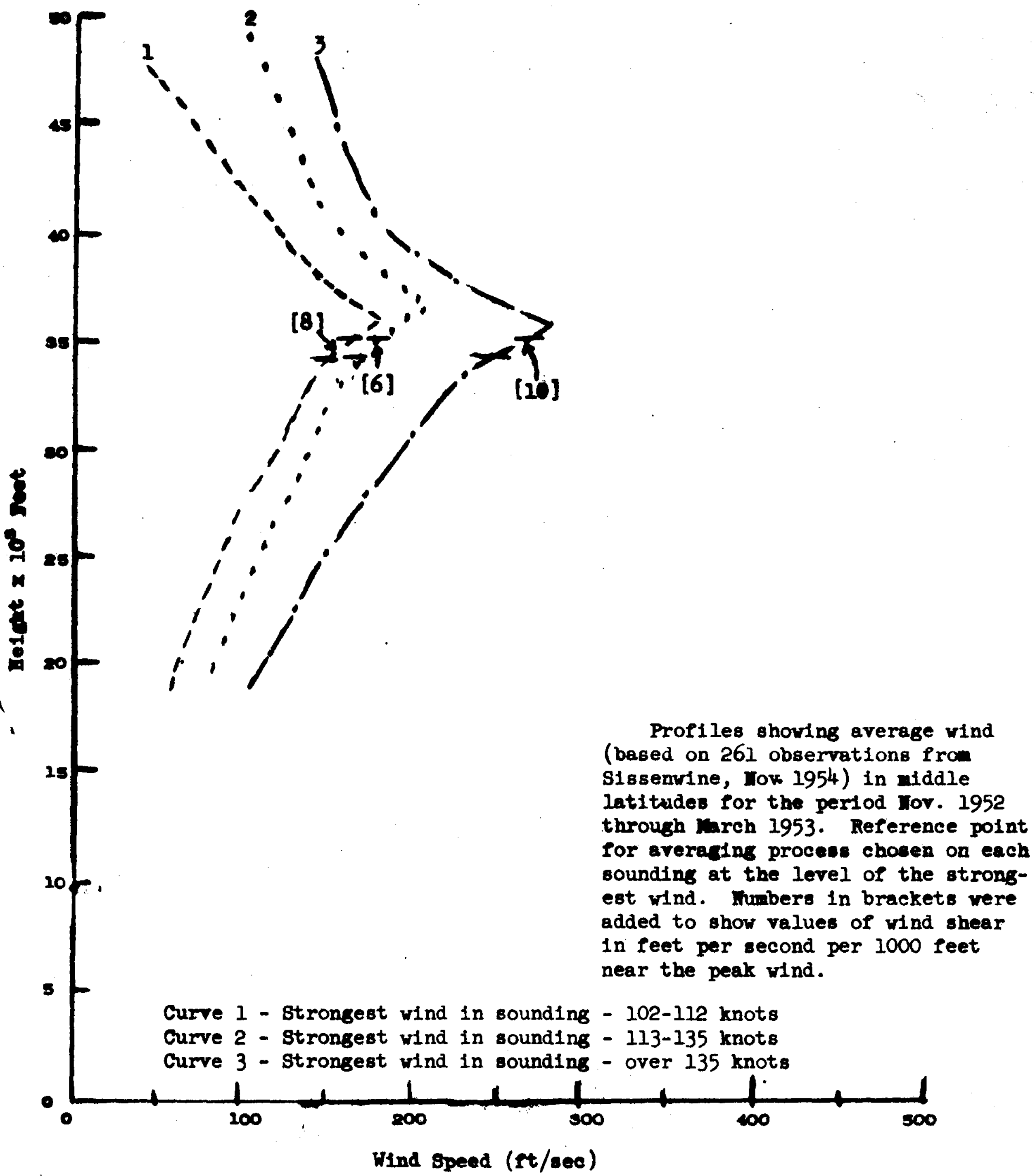


Figure 2. Average Wind Profile

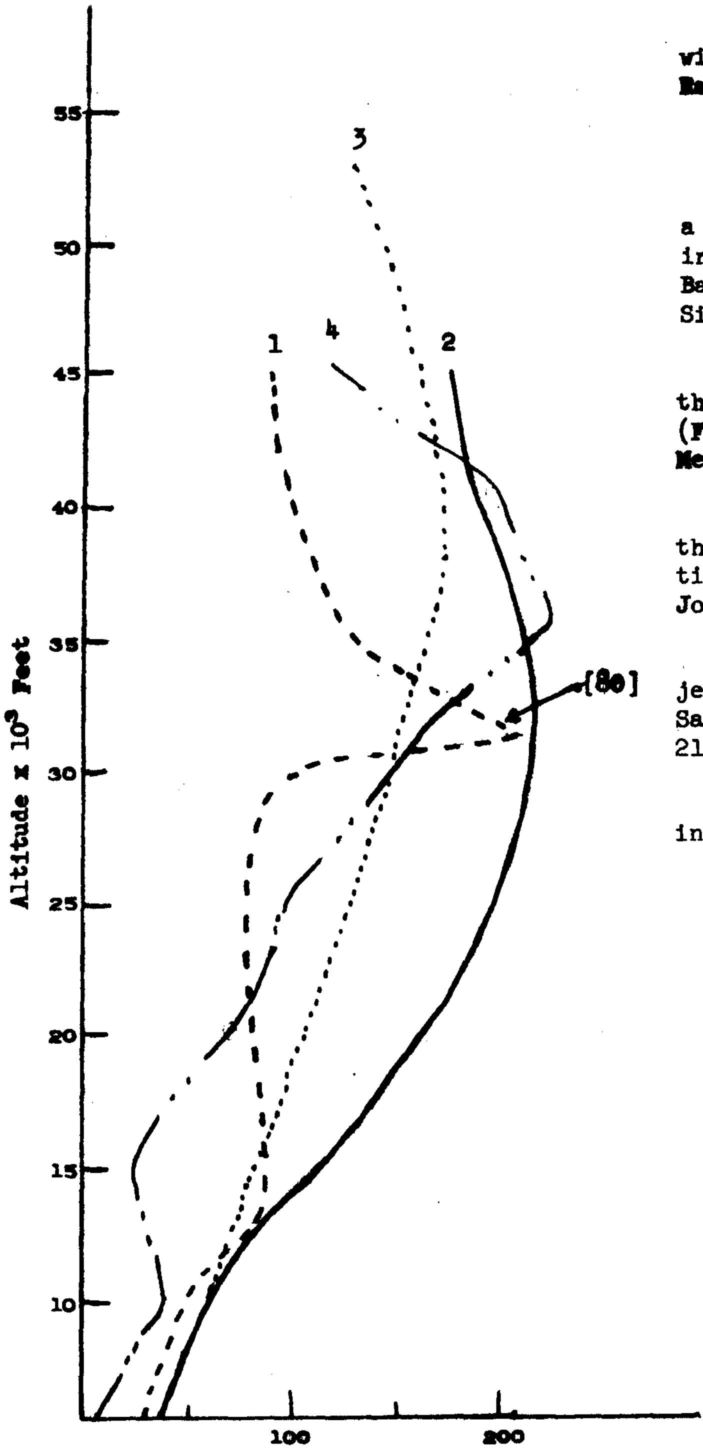
maximum shear as computed for this same wind increment at WSMR was 21.7. At the stronger wind increments, i.e., over 135 knots, it can be seen from Curve 3 that the average vertical shear is approximately 10 feet per second per 1000 feet, whereas in Table II the mean maximum shear for this wind speed increment is more than 30 feet per second per 1000 feet.

Vertical wind profiles through the jet stream are shown in Figure 3. Note that the peak winds occur between 30,000 and 40,000 feet and that the maximum vectorial wind shear is not necessarily at the maximum wind level. Also, it is interesting to see the configuration (Curve 1) that is necessary to yield a wind shear of 80 feet per second per 1000 feet. The instability that is depicted by this curve would tend to smooth out the curve and approximate Curve 4 in a short period of time.

Figure 4 prepared by Diamond, et al [9] reveals the maximum wind shears which can be exceeded one per cent of the time (99 per cent confidence level); El Paso's profile has been added. Note that the wind shear is strongest in the first 1500 feet, decreasing to 2.0×10^{-2} sec^{-1} and remaining relatively constant up to 100,000 feet. The curve for El Paso, Texas, would more nearly represent conditions at WSMR. The 68, 90, 95, and 99 per cent cumulative frequency distributions of vector wind shear at El Paso, Texas, (monthly) are presented in Tables III through XIV. The tables were extracted from the Climatology Ringbook published by the U. S. Army Ordnance Missile Command (AOMC).

CONCLUSIONS

From the data computed at WSMR, it is apparent that the maximum jet wind velocities cannot be significantly correlated to the maximum wind shear for any particular sounding. As can be seen by the quartile distribution, maximum wind shear vector for a given wind increment is quite erratic and can be predicted only in general terms 50 per cent of the time. Means and standard deviations at 1000-foot intervals point out the constancy of wind shear vector as a vehicle ascends through the jet stream.



These curves show a comparison of wind profile over White Sands Missile Range with other installations.

Curve 1. Vertical wind profile through a jet stream with extreme shear. Sounding taken over Wright-Patterson Air Force Base, 1600Z, 2 March 1953. (From Sissenwine, Nov. 1954.)

Curve 2. Vertical wind profile through the center of a typical stormy jet stream. (From Palmer and Nagler, 1948 Journal of Meteorology, p. 62.)

Curve 3. Average vertical wind profile through the center of mean winter position of jet stream. (From Hess, 1948 Journal of Meteorology, p. 298.)

Curve 4. Vertical wind profile through jet stream. Sounding taken over White Sands Missile Range, New Mexico, 6 Dec 61, 2130Z.

Number in bracket is wind shear value in feet per second per 1000 feet.

Figure 3. Vertical Wind Profiles

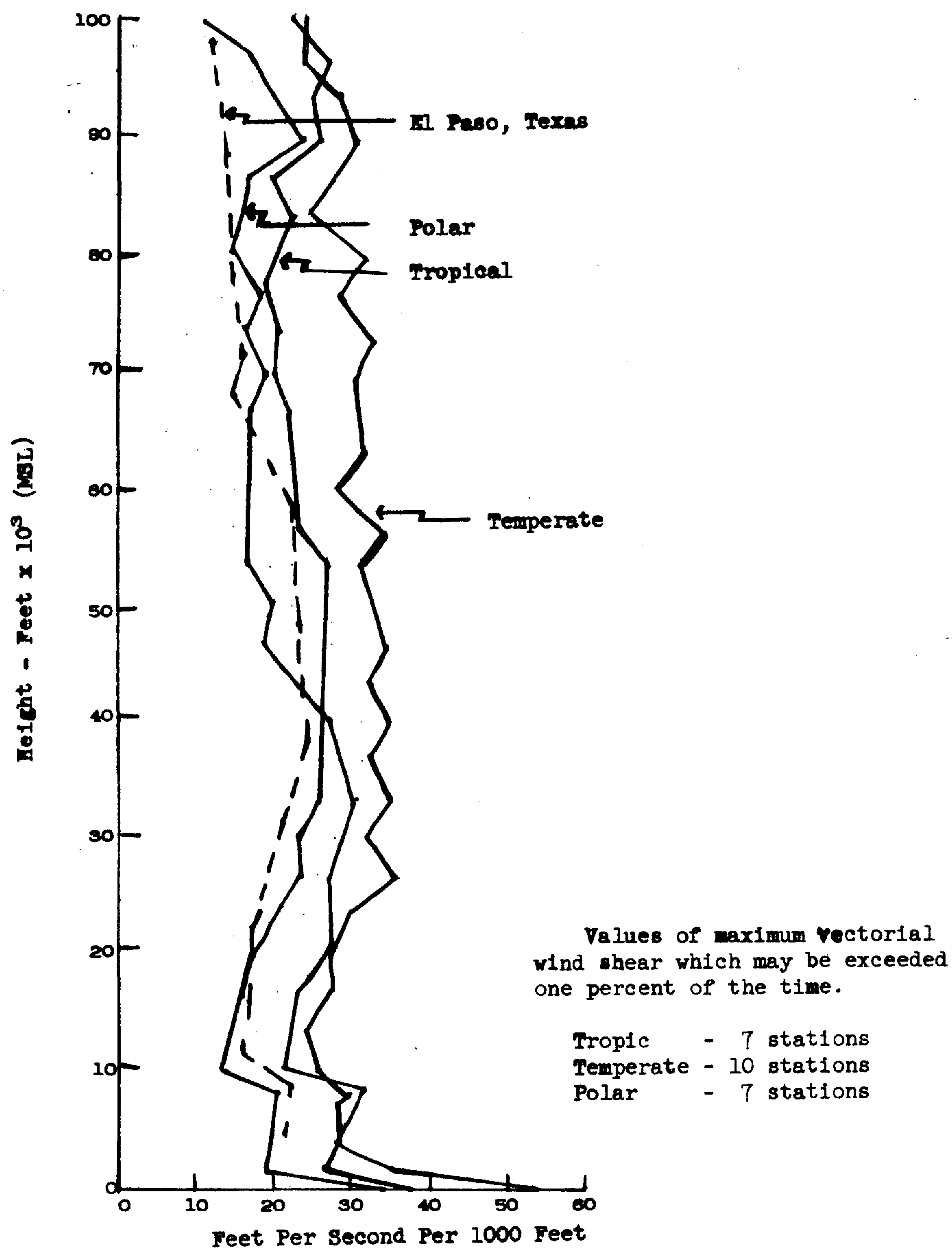


Figure 4. Maximum Vectorial Wind Shear

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TABLE III

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas, Based on Data from 1951 through 1957 for the Month of January. (N = Number of Observations, Units = Sec^{-1}.)

Altitude Km (MSL)	N	Cumulative Percentage Frequency 68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	429	.0116	.0164	.0195	.0228	.0260	.23
2.0 - 2.5	424	.0109	.0160	.0185	.0240	.0330	.24
2.5 - 3.0	414	.0100	.0141	.0161	.0208	.0222	.24
3.0 - 4.0	390	.0064	.0092	.0108	.0153	.0224	.26
4.0 - 5.0	355	.0062	.0103	.0128	.0160	.0230	.28
5.0 - 6.0	300	.0065	.0102	.0118	.0150	.0209	.33
6.0 - 7.0	234	.0070	.0107	.0121	.0190	.0216	.43
7.0 - 8.0	191	.0070	.0130	.0161	.0248	.0265	.52
8.0 - 9.0	160	.0067	.0122	.0169	.0260	.0277	.62
9.0 - 10.0	139	.0070	.0135	.0199	.0289	.0305	.72
10.0 - 11.0	123	.0084	.0150	.0197	.0232	.0362	.81
11.0 - 12.0	111	.0119	.0180	.0210	.0271	.0327	.90
12.0 - 13.0	103	.0110	.0191	.0210	.0272	.0350	.97
13.0 - 14.0	97	.0110	.0174	.0262	.0365	.0365	1.03
14.0 - 15.0	89	.0097	.0155	.0169	.0262	.0262	1.12
15.0 - 16.0	81	.0100	.0150	.0190	.0320	.0320	1.23
16.0 - 17.0	72	.0090	.0138	.0170	.0347	.0347	1.39
17.0 - 18.0	64	.0098	.0126	.0145	.0216	.0216	1.56
18.0 - 19.0	57	.0098	.0135	.0150	.0328	.0328	1.75
19.0 - 20.0	50	.0070	.0093	.0138	.0186	.0186	2.00
20.0 - 21.0	49	.0067	.0100	.0106	.0120	.0120	2.04
21.0 - 22.0	44	.0060	.0088	.0108	.0140	.0140	2.27
22.0 - 23.0	33	.0053	.0070	.0090	.0100	.0100	3.03
23.0 - 24.0	30	.0076	.0099	.0010	.0116	.0116	3.33

TABLE IV

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of February. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	391	.0111	.0151	.0174	.0210	.0273	.26
2.0 - 2.5	386	.0107	.0161	.0192	.0234	.0280	.26
2.5 - 3.0	379	.0095	.0156	.0183	.0274	.0301	.26
3.0 - 4.0	355	.0074	.0110	.0127	.0166	.0186	.28
4.0 - 5.0	318	.0066	.0101	.0125	.0157	.0190	.63
5.0 - 6.0	265	.0070	.0118	.0149	.0175	.0215	.38
6.0 - 7.0	219	.0070	.0114	.0151	.0174	.0180	.46
7.0 - 8.0	181	.0073	.0123	.0148	.0216	.0225	.55
8.0 - 9.0	152	.0080	.0145	.0170	.0238	.0263	.66
9.0 - 10.0	139	.0088	.0151	.0184	.0230	.0241	.72
10.0 - 11.0	132	.0101	.0201	.0230	.0262	.0273	.76
11.0 - 12.0	122	.0104	.0180	.0221	.0277	.0439	.82
12.0 - 13.0	114	.0101	.0157	.0194	.0242	.0263	.88
13.0 - 14.0	103	.0110	.0169	.0190	.0255	.0297	.97
14.0 - 15.0	91	.0110	.0154	.0194	.0230	.0230	1.10
15.0 - 16.0	80	.0096	.0132	.0143	.0190	.0190	1.25
16.0 - 17.0	70	.0100	.0174	.0185	.0219	.0219	1.43
17.0 - 18.0	59	.0080	.0113	.0147	.0280	.0280	1.69
18.0 - 19.0	56	.0084	.0148	.0202	.0237	.0237	1.79
19.0 - 20.0	50	.0077	.0112	.0142	.0166	.0166	2.00
20.0 - 21.0	43	.0058	.0108	.0116	.0250	.0250	2.33
21.0 - 22.0	36	.0069	.0099	.0151	.0176	.0124	3.13
22.0 - 23.0	32	.0052	.0103	.0109	.0124	.0124	3.13

TABLE V

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of March. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	427	.0107	.0148	.0166	.0243	.0304	.23
2.0 - 2.5	424	.0105	.0156	.0184	.0233	.0304	.24
2.5 - 3.0	413	.0100	.0150	.0185	.0244	.0284	.24
3.0 - 4.0	391	.0080	.0111	.0138	.0184	.0214	.26
4.0 - 5.0	344	.0072	.0110	.0130	.0189	.0198	.29
5.0 - 6.0	293	.0069	.0101	.0126	.0168	.0194	.34
6.0 - 7.0	238	.0077	.0132	.0153	.0194	.0222	.42
7.0 - 8.0	204	.0090	.0138	.0165	.0246	.0318	.49
8.0 - 9.0	171	.0090	.0150	.0177	.0260	.0306	.58
9.0 - 10.0	144	.0090	.0160	.0186	.0257	.0305	.69
10.0 - 11.0	129	.0110	.0175	.0192	.0270	.0328	.78
11.0 - 12.0	110	.0120	.0203	.0231	.0277	.0326	.91
12.0 - 13.0	104	.0144	.0210	.0243	.0283	.0311	.96
13.0 - 14.0	86	.0132	.0215	.0244	.0300	.0300	1.16
14.0 - 15.0	78	.0100	.0151	.0170	.0286	.0286	1.28
15.0 - 16.0	70	.0125	.0180	.0210	.0250	.0250	1.43
16.0 - 17.0	64	.0119	.0155	.0192	.0290	.0290	1.56
17.0 - 18.0	56	.0090	.0166	.0215	.0262	.0262	1.79
18.0 - 19.0	53	.0110	.0140	.0154	.0197	.0197	1.89
19.0 - 20.0	48	.0070	.0147	.0206	.0226	.0226	2.08
20.0 - 21.0	42	.0070	.0093	.0111	.0120	.0120	2.76
21.0 - 22.0	35	.0062	.0102	.0167	.0169	.0169	2.86
22.0 - 23.0	31	.0069	.0108	.0127	.0196	.0196	3.23

TABLE VI

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data From 1951 through 1957 for the Month of April. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	416	.0089	.0131	.0156	.0199	.0324	.24
2.0 - 2.5	410	.0094	.0146	.0162	.0223	.0276	.24
2.5 - 3.0	407	.0094	.0149	.0170	.0241	.0297	.25
3.0 - 4.0	395	.0071	.0101	.0111	.0161	.0206	.25
4.0 - 5.0	367	.0070	.0110	.0126	.0156	.0240	.27
5.0 - 6.0	307	.0065	.0100	.0114	.0150	.0213	.33
6.0 - 7.0	263	.0066	.0104	.0125	.0200	.0278	.38
7.0 - 8.0	216	.0060	.0103	.0120	.0197	.0283	.46
8.0 - 9.0	190	.0060	.0111	.0160	.0203	.0208	.53
9.0 - 10.0	161	.0080	.0137	.0160	.0247	.0255	.62
10.0 - 11.0	140	.0082	.0144	.0175	.0219	.0282	.71
11.0 - 12.0	125	.0101	.0170	.0184	.0276	.0370	.80
12.0 - 13.0	108	.0090	.0160	.0180	.0249	.0276	.93
13.0 - 14.0	101	.0096	.0145	.0174	.0190	.0250	.99
14.0 - 15.0	90	.0100	.0150	.0180	.0310	.0310	1.11
15.0 - 16.0	82	.0101	.0134	.0187	.0250	.0250	1.22
16.0 - 17.0	77	.0092	.0162	.0189	.0293	.0293	1.30
17.0 - 18.0	66	.0084	.0130	.0175	.0315	.0315	1.52
18.0 - 19.0	62	.0083	.0133	.0186	.0260	.0260	1.61
19.0 - 20.0	60	.0071	.0111	.0157	.0236	.0236	1.67
20.0 - 21.0	56	.0079	.0125	.0167	.0274	.0274	1.79
21.0 - 22.0	53	.0058	.0117	.0132	.0203	.0203	1.89
22.0 - 23.0	46	.0046	.0079	.0080	.0118	.0118	2.17
23.0 - 24.0	40	.0050	.0070	.0077	.0224	.0224	2.50
24.0 - 25.0	31	.0040	.0075	.0092	.0135	.0135	3.23

TABLE VII

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of May. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	429	.0080	.0133	.0154	.0200	.0240	.23
2.0 - 2.5	425	.0081	.0120	.0148	.0202	.0259	.24
2.5 - 3.0	422	.0083	.0130	.0153	.0215	.0291	.24
3.0 - 4.0	414	.0067	.0095	.0111	.0139	.0156	.24
4.0 - 5.0	386	.0068	.0096	.0112	.0166	.0195	.26
5.0 - 6.0	356	.0067	.0100	.0110	.0137	.0193	.28
6.0 - 7.0	314	.0058	.0088	.0104	.0166	.0208	.32
7.0 - 8.0	285	.0060	.0095	.0115	.0150	.0218	.35
8.0 - 9.0	254	.0060	.0102	.0131	.0170	.0195	.39
9.0 - 10.0	232	.0060	.0107	.0150	.0192	.0218	.43
10.0 - 11.0	214	.0070	.0130	.0160	.0240	.0265	.47
11.0 - 12.0	188	.0070	.0124	.0154	.0192	.0275	.53
12.0 - 13.0	171	.0092	.0140	.0180	.0244	.0244	.58
13.0 - 14.0	160	.0094	.0141	.0160	.0190	.0192	.62
14.0 - 15.0	148	.0094	.0163	.0184	.0279	.0304	.68
15.0 - 16.0	139	.0090	.0130	.0160	.0205	.0205	.72
16.0 - 17.0	132	.0090	.0127	.0165	.0185	.0233	.76
17.0 - 18.0	129	.0095	.0154	.0187	.0241	.0246	.79
18.0 - 19.0	126	.0075	.0121	.0142	.0181	.0255	.83
19.0 - 20.0	120	.0064	.0108	.0118	.0157	.0177	.85
20.0 - 21.0	105	.0058	.0090	.0110	.0149	.0164	.95
21.0 - 22.0	100	.0057	.0093	.0101	.0149	.0167	1.00
22.0 - 23.0	91	.0048	.0071	.0089	.0140	.0140	1.10
23.0 - 24.0	74	.0050	.0074	.0085	.0093	.0093	1.35
24.0 - 25.0	55	.0050	.0070	.0078	.0168	.0168	1.82
25.0 - 26.0	31	.0042	.0072	.0076	.0080	.0080	3.23

TABLE VIII

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of June. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	419	.0080	.0111	.0143	.0183	.0233	.24
2.0 - 2.5	418	.0070	.0102	.0127	.0156	.0280	.24
2.5 - 3.0	418	.0073	.0116	.0140	.0194	.0242	.24
3.0 - 4.0	416	.0058	.0090	.0107	.0139	.0170	.24
4.0 - 5.0	397	.0060	.0083	.0098	.0133	.0150	.25
5.0 - 6.0	371	.0057	.0087	.0100	.0130	.0166	.27
6.0 - 7.0	339	.0050	.0080	.0094	.0122	.0145	.29
7.0 - 8.0	302	.0051	.0076	.0100	.0129	.0161	.33
8.0 - 9.0	282	.0050	.0080	.0092	.0135	.0170	.35
9.0 - 10.0	267	.0057	.0090	.0108	.0148	.0205	.37
10.0 - 11.0	249	.0060	.0090	.0109	.0170	.0198	.40
11.0 - 12.0	240	.0069	.0109	.0131	.0170	.0189	.42
12.0 - 13.0	229	.0074	.0114	.0140	.0192	.0214	.44
13.0 - 14.0	220	.0083	.0138	.0164	.0205	.0225	.45
14.0 - 15.0	209	.0092	.0137	.0154	.0220	.0255	.48
15.0 - 16.0	206	.0085	.0128	.0148	.0219	.0255	.49
16.0 - 17.0	197	.0078	.0130	.0157	.0215	.0252	.51
17.0 - 18.0	189	.0078	.0130	.0157	.0260	.0270	.53
18.0 - 19.0	186	.0067	.0108	.0130	.0167	.0187	.54
19.0 - 20.0	181	.0061	.0095	.0110	.0134	.0142	.55
20.0 - 21.0	180	.0059	.0086	.0104	.0132	.0140	.56
21.0 - 22.0	174	.0054	.0082	.0101	.0148	.0170	.57
22.0 - 23.0	148	.0050	.0065	.0074	.0116	.0120	.68
23.0 - 24.0	124	.0051	.0072	.0081	.0121	.0127	.81
24.0 - 25.0	95	.0050	.0070	.0092	.0134	.0134	1.05
25.0 - 26.0	55	.0065	.0080	.0086	.0167	.0167	1.82

TABLE IX

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of July. (N = Number of Observations, Units = Sec^{-1}.)

Altitude Km (MSL)	N	Cumulative Percentage Frequency 68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	432	.0069	.0101	.0127	.0183	.0272	.23
2.0 - 2.5	428	.0059	.0089	.0114	.0167	.0214	.23
2.5 - 3.0	425	.0062	.0098	.0111	.0144	.0216	.24
3.0 - 4.0	419	.0047	.0069	.0084	.0108	.0131	.24
4.0 - 5.0	400	.0044	.0069	.0079	.0107	.0184	.25
5.0 - 6.0	373	.0050	.0071	.0078	.0111	.0121	.27
6.0 - 7.0	346	.0046	.0070	.0079	.0101	.0142	.29
7.0 - 8.0	325	.0050	.0075	.0088	.0107	.0166	.31
8.0 - 9.0	307	.0044	.0073	.0084	.0117	.0125	.33
9.0 - 10.0	291	.0047	.0071	.0083	.0104	.0148	.34
10.0 - 11.0	277	.0053	.0077	.0096	.0121	.0148	.36
11.0 - 12.0	270	.0056	.0080	.0103	.0140	.0154	.37
12.0 - 13.0	263	.0058	.0096	.0110	.0144	.0166	.38
13.0 - 14.0	256	.0066	.0100	.0120	.0171	.0195	.39
14.0 - 15.0	245	.0069	.0097	.0125	.0180	.0224	.41
15.0 - 16.0	231	.0069	.0105	.0121	.0148	.0163	.43
16.0 - 17.0	228	.0070	.0098	.0121	.0184	.0202	.44
17.0 - 18.0	221	.0060	.0097	.0115	.0142	.0225	.45
18.0 - 19.0	215	.0059	.0090	.0100	.0124	.0149	.47
19.0 - 20.0	212	.0057	.0080	.0095	.0112	.0210	.47
20.0 - 21.0	204	.0058	.0085	.0107	.0142	.0249	.49
21.0 - 22.0	192	.0055	.0074	.0087	.0124	.0139	.52
22.0 - 23.0	174	.0060	.0081	.0097	.0134	.0155	.57
23.0 - 24.0	150	.0060	.0081	.0097	.0114	.0163	.67
24.0 - 25.0	116	.0050	.0081	.0100	.0132	.0133	.86
25.0 - 26.0	78	.0060	.0090	.0100	.0130	.0130	1.28
26.0 - 27.0	39	.0062	.0098	.0139	.0140	.0140	2.56

TABLE X

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of August. (N = Number of Observations, Units = Sec^{-1}.)

Altitude Km (MSL)	N	Cumulative Percentage Frequency 68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	432	.0065	.0100	.0117	.0180	.0247	.23
2.0 - 2.5	432	.0060	.0092	.0120	.0148	.0255	.23
2.5 - 3.0	430	.0061	.0092	.0107	.0135	.0225	.23
3.0 - 4.0	423	.0046	.0064	.0072	.0093	.0115	.24
4.0 - 5.0	389	.0040	.0058	.0067	.0092	.0111	.26
5.0 - 6.0	367	.0042	.0061	.0076	.0092	.0102	.27
6.0 - 7.0	344	.0039	.0061	.0070	.0103	.0130	.29
7.0 - 8.0	315	.0043	.0060	.0074	.0102	.0122	.32
8.0 - 9.0	295	.0047	.0066	.0088	.0112	.0139	.34
9.0 - 10.0	278	.0050	.0071	.0086	.0113	.0124	.36
10.0 - 11.0	273	.0050	.0075	.0090	.0125	.0160	.37
11.0 - 12.0	267	.0057	.0084	.0099	.0121	.0129	.37
12.0 - 13.0	263	.0060	.0090	.0100	.0130	.0150	.38
13.0 - 14.0	262	.0059	.0090	.0112	.0150	.0163	.38
14.0 - 15.0	252	.0069	.0115	.0130	.0187	.0234	.40
15.0 - 16.0	241	.0066	.0099	.0112	.0167	.0210	.41
16.0 - 17.0	226	.0067	.0102	.0120	.0130	.0163	.44
17.0 - 18.0	217	.0059	.0091	.0102	.0121	.0175	.46
18.0 - 19.0	214	.0064	.0089	.0099	.0130	.0303	.47
19.0 - 20.0	212	.0060	.0085	.0095	.0118	.0123	.47
20.0 - 21.0	209	.0054	.0080	.0099	.0122	.0141	.48
21.0 - 22.0	191	.0055	.0080	.0103	.0168	.0170	.52
22.0 - 23.0	178	.0057	.0080	.0100	.0157	.0170	.56
23.0 - 24.0	148	.0060	.0090	.0111	.0147	.0221	.68
24.0 - 25.0	107	.0055	.0080	.0088	.0102	.0106	.93
25.0 - 26.0	67	.0064	.0091	.0110	.0140	.0140	1.49
26.0 - 27.0	30	.0060	.0082	.0097	.0125	.0125	3.33

TABLE XI

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of September. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	418	.0067	.0109	.0130	.0168	.0291	.24
2.0 - 2.5	217	.0069	.0102	.0131	.0162	.0202	.24
2.5 - 3.0	417	.0067	.0104	.0123	.0153	.0213	.24
3.0 - 4.0	413	.0050	.0078	.0086	.0110	.0122	.24
4.0 - 5.0	394	.0050	.0070	.0081	.0118	.0134	.25
5.0 - 6.0	379	.0050	.0080	.0092	.0128	.0149	.26
6.0 - 7.0	354	.0050	.0075	.0088	.0103	.0148	.28
7.0 - 8.0	332	.0054	.0085	.0100	.0129	.0157	.30
8.0 - 9.0	310	.0060	.0091	.0111	.0156	.0205	.32
9.0 - 10.0	287	.0069	.0110	.0122	.0160	.0200	.35
10.0 - 11.0	270	.0070	.0104	.0121	.0195	.0207	.37
11.0 - 12.0	251	.0065	.0105	.0121	.0159	.0176	.40
12.0 - 13.0	238	.0064	.0110	.0121	.0179	.0246	.42
13.0 - 14.0	225	.0070	.0120	.0137	.0210	.0320	.44
14.0 - 15.0	211	.0082	.0127	.0150	.0188	.0341	.47
15.0 - 16.0	198	.0080	.0122	.0140	.0200	.0210	.51
16.0 - 17.0	188	.0077	.0121	.0136	.0203	.0226	.53
17.0 - 18.0	181	.0071	.0112	.0130	.0156	.0192	.55
18.0 - 19.0	174	.0060	.0095	.0115	.0195	.0256	.57
19.0 - 20.0	170	.0059	.0090	.0113	.0177	.0232	.59
20.0 - 21.0	164	.0061	.0089	.0110	.0145	.0163	.61
21.0 - 22.0	154	.0054	.0080	.0092	.0135	.0150	.65
22.0 - 23.0	133	.0051	.0080	.0112	.0133	.0144	.75
23.0 - 24.0	108	.0050	.0070	.0074	.0095	.0101	.93
24.0 - 25.0	75	.0047	.0067	.0111	.0140	.0140	1.33
25.0 - 26.0	45	.0051	.0089	.0106	.0120	.0120	2.22

TABLE XII

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of October. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	432	.0084	.0127	.0145	.0200	.0285	.23
2.0 - 2.5	430	.0080	.0123	.0140	.0179	.0255	.23
2.5 - 3.0	427	.0080	.0121	.0141	.0203	.0282	.23
3.0 - 4.0	419	.0057	.0086	.0100	.0130	.0153	.24
4.0 - 5.0	406	.0053	.0081	.0097	.0135	.0175	.25
5.0 - 6.0	386	.0050	.0077	.0096	.0124	.0159	.26
6.0 - 7.0	365	.0050	.0080	.0101	.0156	.0173	.27
7.0 - 8.0	327	.0054	.0090	.0107	.0160	.0210	.31
8.0 - 9.0	288	.0070	.0109	.0130	.0210	.0233	.35
9.0 - 10.0	261	.0073	.0116	.0130	.0211	.0333	.38
10.0 - 11.0	241	.0073	.0109	.0142	.0180	.0205	.41
11.0 - 12.0	220	.0084	.0129	.0151	.0245	.0295	.45
12.0 - 13.0	204	.0077	.0142	.0158	.0194	.0220	.49
13.0 - 14.0	178	.0080	.0130	.0168	.0200	.0217	.56
14.0 - 15.0	159	.0080	.0130	.0155	.0207	.0277	.63
15.0 - 16.0	149	.0090	.0125	.0135	.0160	.0186	.67
16.0 - 17.0	139	.0081	.0124	.0143	.0205	.0220	.72
17.0 - 18.0	134	.0072	.0128	.0156	.0222	.0260	.75
18.0 - 19.0	131	.0069	.0110	.0122	.0167	.0200	.76
19.0 - 20.0	126	.0058	.0088	.0105	.0120	.0148	.79
20.0 - 21.0	123	.0064	.0090	.0102	.0142	.0228	.81
21.0 - 22.0	114	.0055	.0080	.0088	.0118	.0120	.88
22.0 - 23.0	95	.0054	.0079	.0092	.0142	.0142	1.05
23.0 - 24.0	69	.0047	.0072	.0094	.0136	.0136	1.45
24.0 - 25.0	47	.0051	.0075	.0090	.0093	.0093	2.13

TABLE XIII

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of November. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	413	.0110	.0165	.0195	.0253	.0260	.23
2.0 - 2.5	413	.0100	.0147	.0180	.0256	.0320	.24
2.5 - 3.0	406	.0087	.0137	.0167	.0242	.0337	.25
3.0 - 4.0	392	.0062	.0105	.0119	.0165	.0200	.26
4.0 - 5.0	370	.0060	.0099	.0125	.0159	.0178	.27
5.0 - 6.0	333	.0060	.0100	.0123	.0171	.0200	.30
6.0 - 7.0	291	.0070	.0109	.0143	.0205	.0278	.34
7.0 - 8.0	264	.0070	.0114	.0137	.0225	.0263	.38
8.0 - 9.0	229	.0070	.0126	.0166	.0207	.0282	.44
9.0 - 10.0	197	.0084	.0130	.0160	.0220	.0370	.51
10.0 - 11.0	176	.0090	.0159	.0215	.0298	.0320	.57
11.0 - 12.0	154	.0096	.0162	.0180	.0210	.0230	.65
12.0 - 13.0	142	.0093	.0165	.0198	.0254	.0295	.70
13.0 - 14.0	129	.0103	.0173	.0181	.0226	.0252	.78
14.0 - 15.0	121	.0096	.0144	.0179	.0224	.0241	.83
15.0 - 16.0	111	.0090	.0140	.0164	.0205	.0264	.90
16.0 - 17.0	105	.0090	.0130	.0142	.0225	.0264	.95
17.0 - 18.0	104	.0084	.0128	.0150	.0195	.0196	.96
18.0 - 19.0	99	.0073	.0112	.0136	.0157	.0157	1.01
19.0 - 20.0	97	.0061	.0090	.0112	.0144	.0144	1.03
20.0 - 21.0	93	.0059	.0081	.0111	.0137	.0137	1.08
21.0 - 22.0	86	.0057	.0086	.0096	.0137	.0137	1.16
22.0 - 23.0	79	.0057	.0084	.0100	.0117	.0117	1.27
23.0 - 24.0	55	.0051	.0086	.0118	.0120	.0120	3.64
24.0 - 25.0	36	.0070	.0097	.0132	.0169	.0169	2.78

TABLE XIV

Frequency Distribution of Vectorial Wind Shear at El Paso, Texas Based on Data from 1951 through 1957 for the Month of December. (N = Number of Observations, Units = Sec^{-1}.)

Cumulative Percentage Frequency

Altitude Km (MSL)	N	68.0	90.0	95.0	99.0	Max. Shear	Pct. Freq.
1.5 - 2.0	431	.0115	.0166	.0184	.0260	.0330	.23
2.0 - 2.5	427	.0101	.0160	.0179	.0255	.0320	.23
2.5 - 3.0	420	.0088	.0141	.0175	.0220	.0288	.24
3.0 - 4.0	402	.0051	.0108	.0123	.0175	.0200	.25
4.0 - 5.0	374	.0065	.0094	.0113	.0157	.0237	.27
5.0 - 6.0	335	.0067	.0104	.0135	.0163	.0220	.30
6.0 - 7.0	296	.0065	.0100	.0131	.0153	.0176	.34
7.0 - 8.0	253	.0078	.0123	.0141	.0201	.0220	.40
8.0 - 9.0	212	.0078	.0131	.0168	.0217	.0269	.47
9.0 - 10.0	185	.0082	.0130	.0169	.0203	.0223	.54
10.0 - 11.0	173	.0100	.0147	.0173	.0291	.0319	.58
11.0 - 12.0	158	.0094	.0177	.0200	.0289	.0303	.63
12.0 - 13.0	145	.0097	.0168	.0196	.0246	.0291	.69
13.0 - 14.0	134	.0103	.0159	.0196	.0238	.0335	.75
14.0 - 15.0	128	.0100	.0150	.0170	.0230	.0285	.78
15.0 - 16.0	123	.0090	.0134	.0148	.0199	.0248	.81
16.0 - 17.0	114	.0090	.0135	.0155	.0210	.0230	.88
17.0 - 18.0	104	.0085	.0134	.0150	.0253	.0284	.96
18.0 - 19.0	99	.0090	.0120	.0163	.0263	.0263	1.01
19.0 - 20.0	95	.0074	.0120	.0169	.0205	.0205	1.05
20.0 - 21.0	85	.0069	.0115	.0127	.0206	.0206	1.18
21.0 - 22.0	77	.0069	.0110	.0137	.0184	.0184	1.30
22.0 - 23.0	66	.0064	.0086	.0094	.0266	.0266	1.52
23.0 - 24.0	54	.0079	.0122	.0075	.0214	.0214	1.85
24.0 - 25.0	36	.0064	.0107	.0132	.0160	.0160	2.78

REFERENCES

1. Byers, Horace Robert, "General Meteorology," 3rd Edition, McGraw-Hill Book Company, New York, 1959, pp 277-278.

2. Lees, Sidney, "Study on Wind Shear Measurements," Final Report, Signal Corps Contract Nr. DA-36-039 SC-73204, U. S. Army Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey.

3. Arnold, Abraham, "On the Theory of Wind-Shear Measurement," Technical Report #2155, U. S. Army Signal Research and Development Laboratory, Ft. Monmouth, New Jersey.

4. Reisig, G. H. R., "Characteristic Quantities of Wind Field Above White Sands Proving Ground, New Mexico," Aeroballistics Memo Nr. 39, 15 April 1952.

5. Reed, J. W., "The Representativeness of Winds Aloft Observations," BAMS, 35, No. 6, 253-6, June 1954.

6. Laurin, Louis D., et al, "Accuracy of Upper Air Data" from Detachment 11, 4th Weather Group to all Project Officers and Contractors, April 1954.

7. U. S. Department of Commerce, Upper-Wind Test Project, Washington, D.C., 1958.

8. Sissenwine, Norman, "Windspeed Profile, Windshear, and Gusts for Design of Guidance Systems for Vertical Rising Air Vehicles," Geophysics Research Directorate No. 57, Air Force Cambridge Research Center, November 1954.

9. Diamond, Marvin and Oskar M. Essenwanger, "Atmospheric Environmental Test and Design Criteria," U. S. Army Electronics Research and Development Activity, Missile Meteorology Division, White Sands Missile Range, New Mexico, September 1962.

N O T I C E S

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FOR THE COMMANDER:

L. W. ALBRO
Major, AGC
Adjutant

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Army Electronics Research and Development Activity, Missile Meteorology Division, White Sands Missile Range, New Mexico

WIND SHEAR IN THE JET STREAM AT WHITE SANDS MISSILE Range, By Manuel Armendariz, Emmit Fisher, and Juana Serna, Technical Report SELWS-M-13, November 1962, 26 pp incl Illus.

UNCLASSIFIED REPORT

A discussion of wind shear in the jet stream over White Sands Missile Range, New Mexico, is presented. Wind data collected utilizing the GMD-1 system are used to calculate vectorial wind shear. The maximum jet wind speed could not be significantly correlated to the maximum wind shear for any particular observation. Mean vectorial wind shear and standard deviation for each thousand feet of height in the jet stream are included.

1. Jet Stream
2. Wind Shear
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